



Continuing Progress in 450mm Development



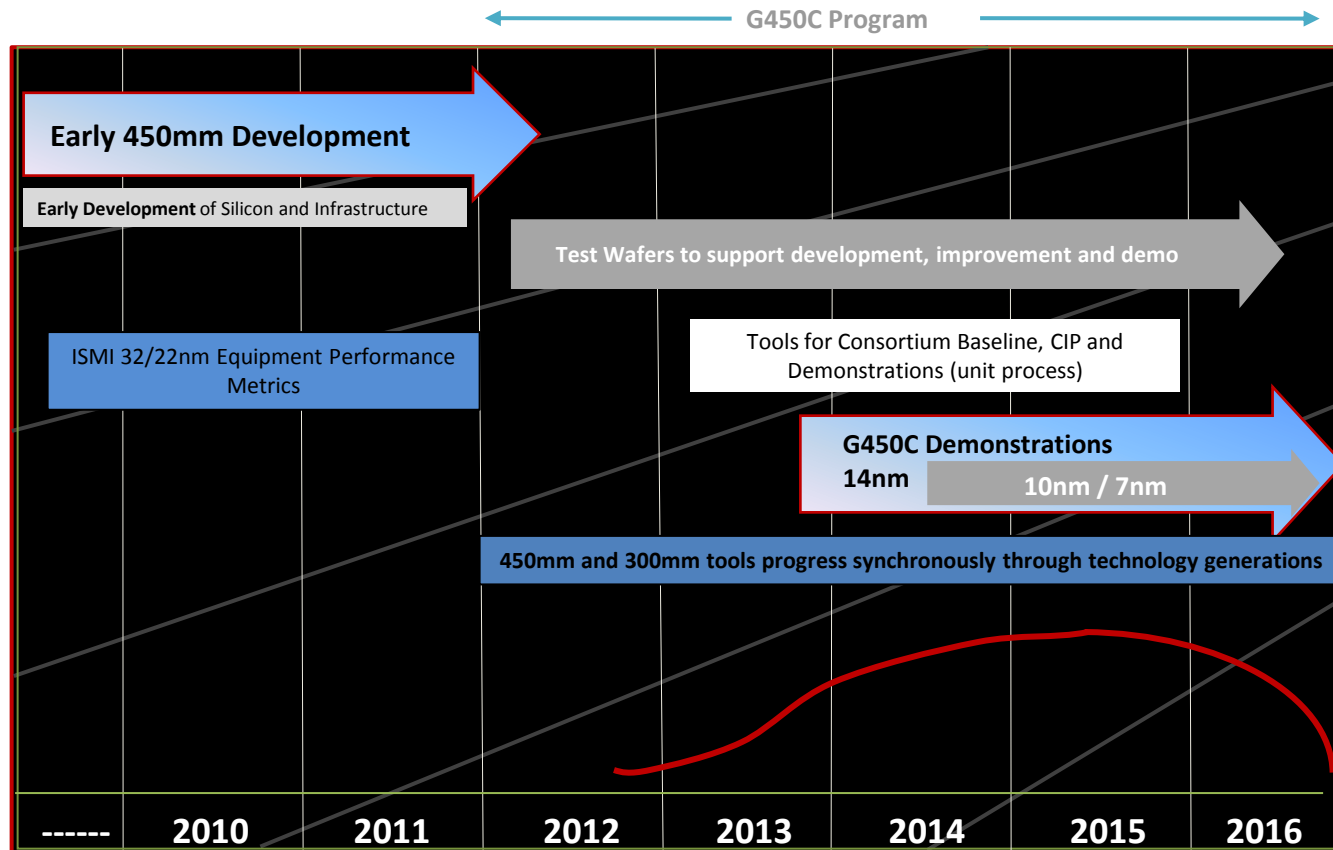
October 8, 2014
SEMICON Europa

Key Messages

- Program progress continues with broad Supplier support
- Technical results are excellent with few capabilities identified as challenges
- Wafer supply
 - Initial M1 grade wafers received
 - Notchless wafer standard ballot approved

CNSE – RF / GLOBALFOUNDRIES / Intel / IBM / Samsung / TSMC

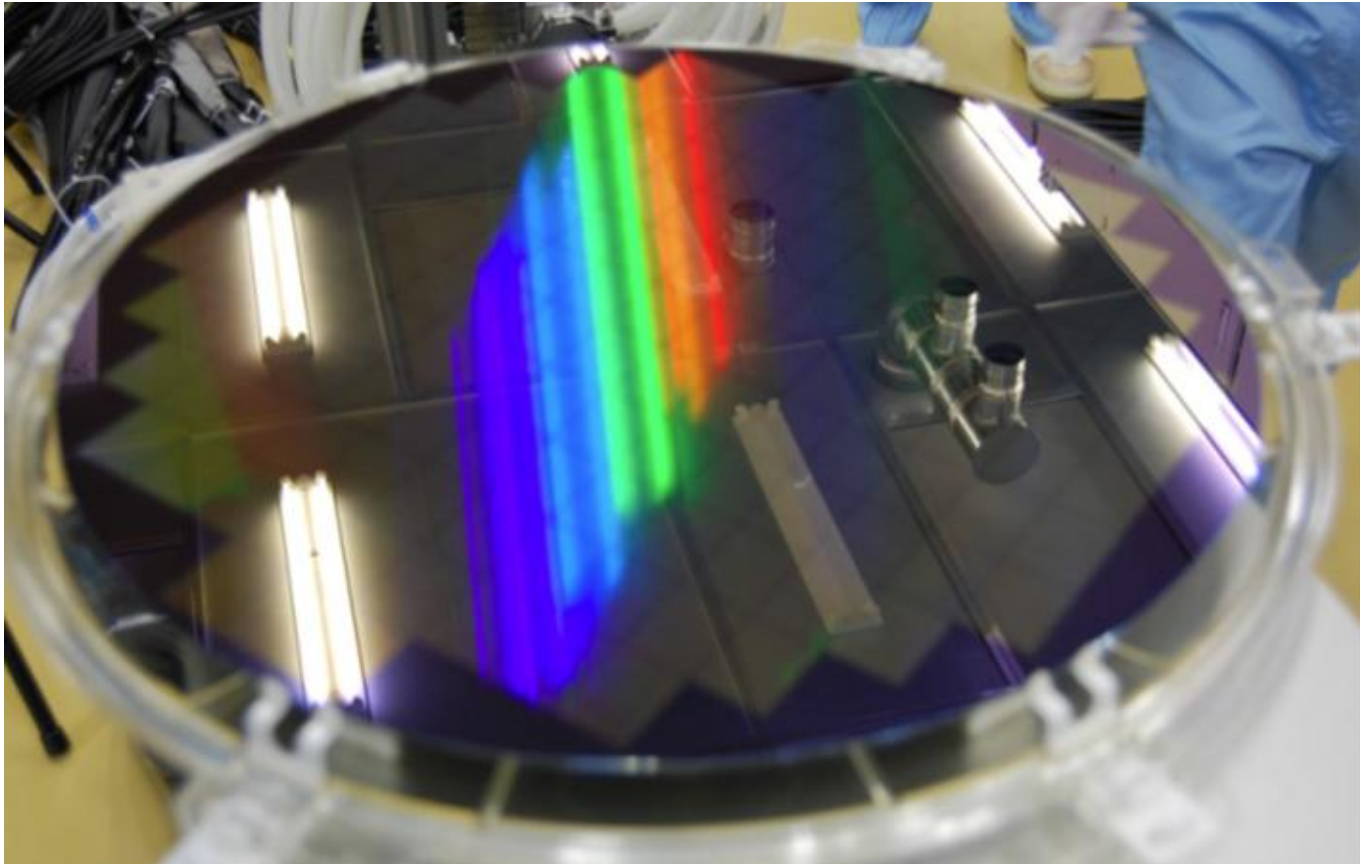
Development and Technology Intercept Targets



Likely profile of tool work scope from tool delivery to program completion

Full set (60+) of process and metrology tools and automation

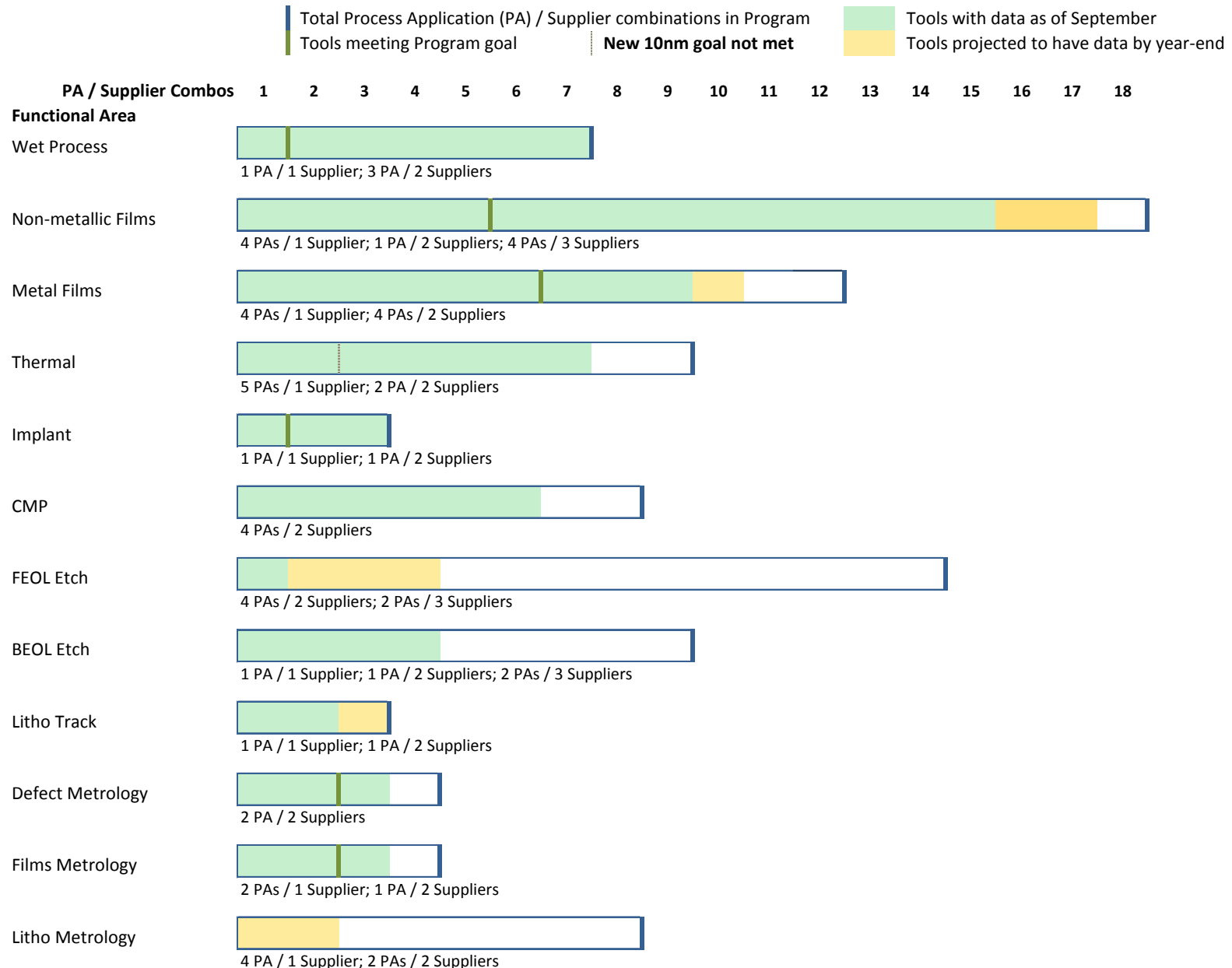
CNSE – RF / GLOBALFOUNDRIES / Intel / IBM / Samsung / TSMC



450mm 193i Patterned Wafer
Courtesy Nikon Corporation

CNSE – RF / GLOBALFOUNDRIES / Intel / IBM / Samsung / TSMC

Process Capability Data Progress



- Sub-10nm EPM published as of SEMICON West
- Based on the uncertainties of sub-10nm process applications, modified metrics to include various process options
 - “Metal-plug” to replace “W-plug”; “barrier” instead of “Ti/TiN barrier”; “salicide” instead of “Ni salicide”.
 - Modified epitaxy to include possible options beyond SiGe.
 - Include ALD option for various films.
- Instead of planar, FIN/STI structure will be the target structure
- Design rules and aspect ratio: referred but not fully aligned to ITRS roadmap. Modification based upon:
 - Inputs from member companies, suppliers and collaborating consortia
 - “Realistic and achievable” for tool qualification and CIP goals.

Thanks to EEMI450 Partners for Valuable Input!

G450C / EEMI450 / Metro450 Collaboration

- EEMI450 feedback (including IMEC and Suppliers) improved multiple parameters in sub-10nm Equipment Performance Metrics
- Joint planning on ASM furnace demo at G450C and Recif sorter demo at IMEC: standard methods / data exchange
 - Working with Metro450 to address slip measurement
 - Planning contamination analysis by Fraunhofer and TNO
- Planning fabrication of standard calibration wafer with Metro450

Ongoing Facilities / EHS work with F450C

- Pump / Abatement Green Mode
 - Communication network installed
 - Baseline fingerprinting under way
- Utilities use rates, effluent characterization
 - Sensors, data collection system installed
- GHG emissions
 - Expect to begin 4Q14
- He recycling
 - Defining project scope

As wafer diameter increases to 450mm, surface area increases by 2.25 times and process gas flows are expected to grow by up to 3 times.

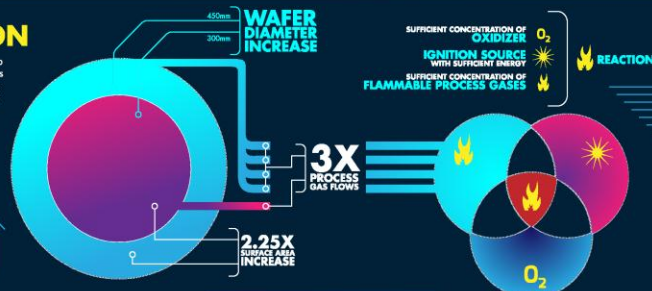
THE SITUATION

As wafer diameter increases to 450mm, surface area increases by 2.25 times and process gas flows are expected to grow by up to 3 times.

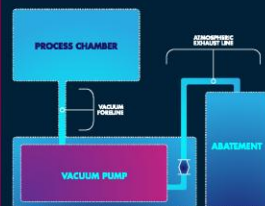
450mm
200mm

WAFER DIAMETER INCREASE

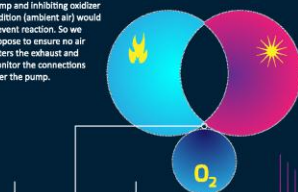
2.25X CONTACT AREA INCREASE



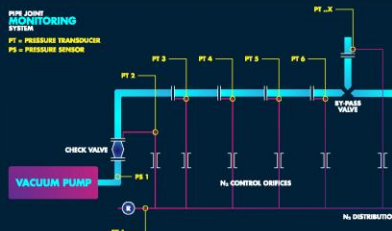
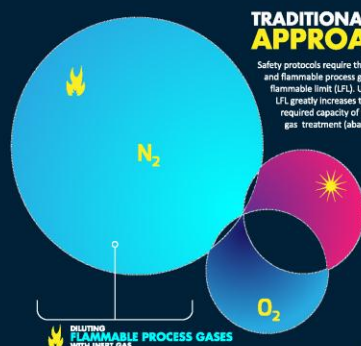
Reactions occur typically at > 50 mbar (0.725 psi or 5 KPa or 37.5 Torr). So the primary area of concern is after the vacuum pump.



Flammable gases are prescribed in the process recipes, ignition potential is part of the mechanics of the pump and inhibiting oxidizer addition (ambient air) would prevent reaction. So we propose to ensure no air enters the exhaust and monitor the connections after the pump.



Safety protocols require the dilution of pyrophoric and flammable process gases to below their lower flammable limit (LFL). Using N_2 to meet $\frac{1}{2}$ or $\frac{1}{4}$ of LFL greatly increases the total flow and the required capacity of the point-of-use exhaust gas treatment (abatement).

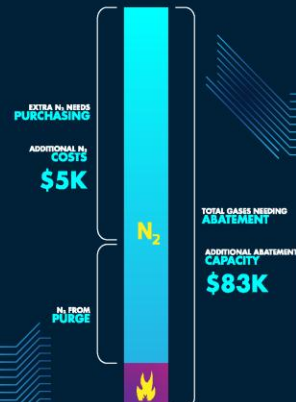


| | | | | | |
|--|------|------------------------------------|----------------------|--------------------|--------|
| <p>Each connection is a hybrid NW40 / NW50 fitting with the space in between concentric o-rings under N₂ pressure. A change in that pressure (which is monitored by a safety PLC programmable logic controller) then causes a warning or an alarm to be issued.</p> | TEST | CONFIRM | UP STREAM PRESSURE | DETECTION PRESSURE | RESULT |
| | 1 | Protection during leak | Leak detection limit | | 73 MPa |
| | | System identifies which connection | 13 sig | 7 sig | YES |

A test set up was constructed in the

Rethinking the approach to higher 450mm process gas flows: a case study

The LFL of silane is 1.37% of total flow. At a Silane gas flow of 2 slm, 1/3 LFL would require the addition of 292 slm of N₂ at the exhaust of the pump. If 96 slm comes from the pump purge another 196 slm must be added. If 600 slm of abatement capacity costs (simplified) \$200,000 and N₂ costs \$0.5/m³ then:



**SIMPLIFIED FIRST YEAR
COST AVOIDED WITH
MONITORED
CONNECTION**

\$88K

**INTEGRATING MONITORED CONNECTIONS INTO AN
INTEGRATED SUBFAB PACKAGE
CAN PROVIDE SAFE COST REDUCTION
AND RESOURCE CONSERVATION**

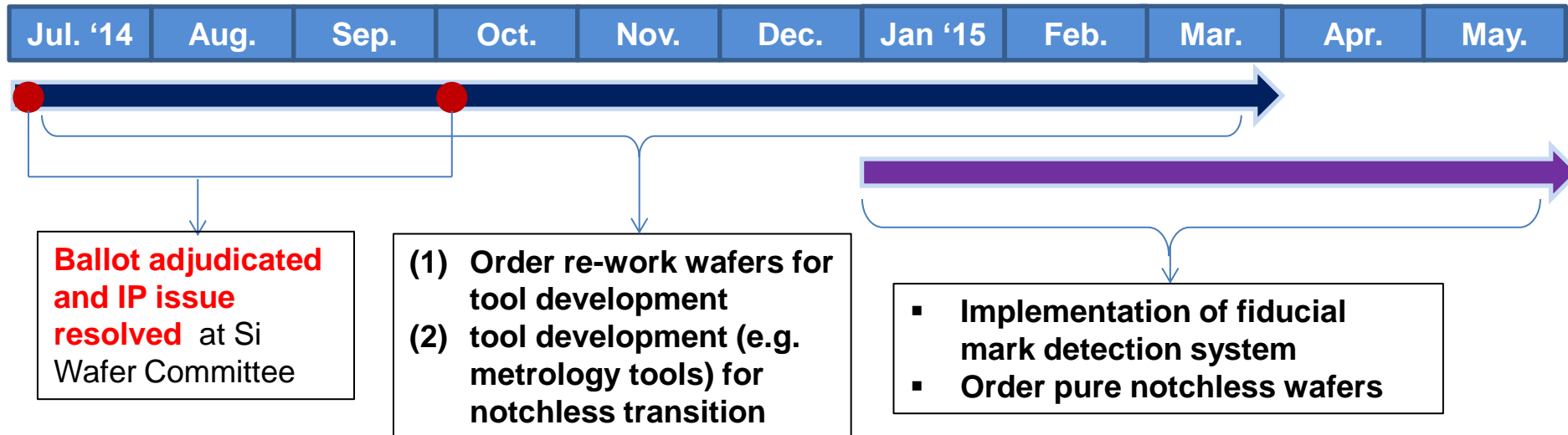
Acknowledgments
 64502C: Frank Robertson, Ben Hall
 OSG: Timothy Storer
 Contacts: John Huang, Jason Hall, David Hale, Al Brightman, Anthony Keen, Jay Pease

Contact Information
 william.curtis@nsls.gov
 AlAnna.gandy@nsls-streets.com

Addressing
process gas
use rate
concern at
450mm that
can benefit
300mm!

Notchless Wafer Timeline

- The notchless standards (M1 & M20) will be completed by October, 2014. The IP issue should be resolved at SEMICON Europa in October
- The notchless transition started already: some tools, e.g. KLA-T SP3 & WS3 and Nikon 193i, can take notchless wafers now
- The primary fiducial mark has been decided at 180° from the notch of re-worked wafers. G450C plans to order up to 3000 re-work wafers
- G450C plans to order up to 700 pure notchless wafers for future usage



- **SEMI Equipment Energy Savings Mode Task Force (aka “Green Mode”)**
 - Developing fab-wide control framework → likely 2015 SEMI standards
- **SEMI 450mm Physical Interfaces & Carriers**
 - Working with ITG-J to eliminate 450mm carrier issues found at G450C
- **SEMI Defectivity Subcommittee**
 - Working to improve quality of consumables causing sub-10nm defects
 - Starting with ‘O’-rings and valve seals
- **SEMI Wait Time Waste Task Force**
 - SECS log file data extraction for G450C offsite equipment
- **450mm Component Lift Working Group**
 - Component lift guidelines issued

Summary

- 450mm technical results are excellent
- 193i patterning capability demonstrated
- Notchless wafer standard approved
- Program progress continues
- Global collaboration important as ever